L. L. NARAYANA*: A contribution to the floral anatomy of Oxalidaceae

ナラヤナ, エル・エル*: カタバミ科の花部形態の研究

Introduction. The family Oxalidaceae was not received much attention from the point of view of floral anatomy. Saunders (1937) studied a few species mainly with a view to support her theory of carpel polymorphism. The present study deals with the floral anatomy of *Averrhoa bilimbi* L., *A. carambola* L., *Biophytum intermedium* Wight, *Oxalis corymbosa* DC., *O. latifolia* H. B. & K., *O. pescaprae L.*, *O. pubescens* H. B. & K. and *Sarcotheca subtriplinervis* Hall. f.

Material and Methods. All the material was fixed in F.A.A. Customary methods of dehydration, infiltration and embedding were followed. Sections cut at a thickness of 10–12 microns were stained in crystal violet using erythrosin as the counter stain. The floral anatomy of *Sarcotheca subtriplinervis* was studied with the help of the herbarium material. The method employed for processing the material was the same as described for *Durandea* (Narayana, 1964).

Morphology of the flower. The flower is pedicellate, bisexual, regular, hypogynous, pentamerous and pentacyclic. The sepals show quincuncial aestivation (Figs. 2-4, 12, 20, 21, 30-33, 38-42, 45-48) and are free in *Averrhoa bilimbi*, *A. carambola* and *Biophytum intermedium* (Figs. 2-4, 12, 20, 21). In *Oxalis* species and *Sarcotheca subtriplinervis* they show basal connation (Fig. 47). The corolla is polypetalous and shows contorted aestivation (Figs. 7, 13, 26, 27, 34, 35, 41, 42, 48, 49). However, some flowers of *Averrhoa bilimbi* and *A. carambola* show imbricate and quincuncial aestivation respectively (Figs. 6, 14). The androecium consists of ten stamens which are basally connate (Figs. 5, 13, 23, 33, 40, 48). They are of two heights, the antipetalous being shorter (Figs. 6, 7, 26, 27, 34, 35, 41, 42, 49). In *Averrhoa carambola* the antipetalous stamens are reduced to staminodes (Fig. 14). The gynoecium is pentacarpellary, pentalocular becoming unilocular towards the top (Figs. 6, 13, 14, 25, 26, 34, 35, 41, 42, 49). There are two or more ovules in each loculus and they are superposed (Figs. 17, 50). The styles are free (Figs. 7, 16, 27) and the stigmas bear glandular hairs.

Floral anatomy. The pedicel shows a ring of discrete vascular bundles (Figs.

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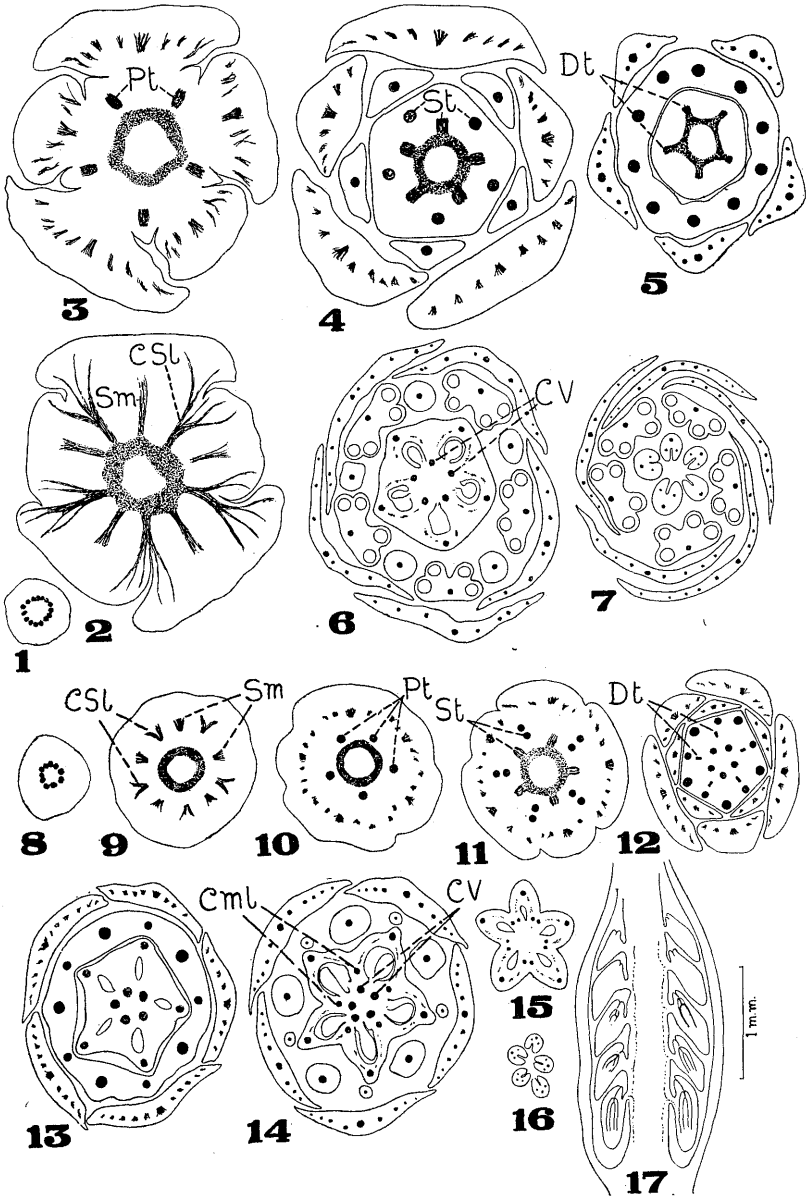
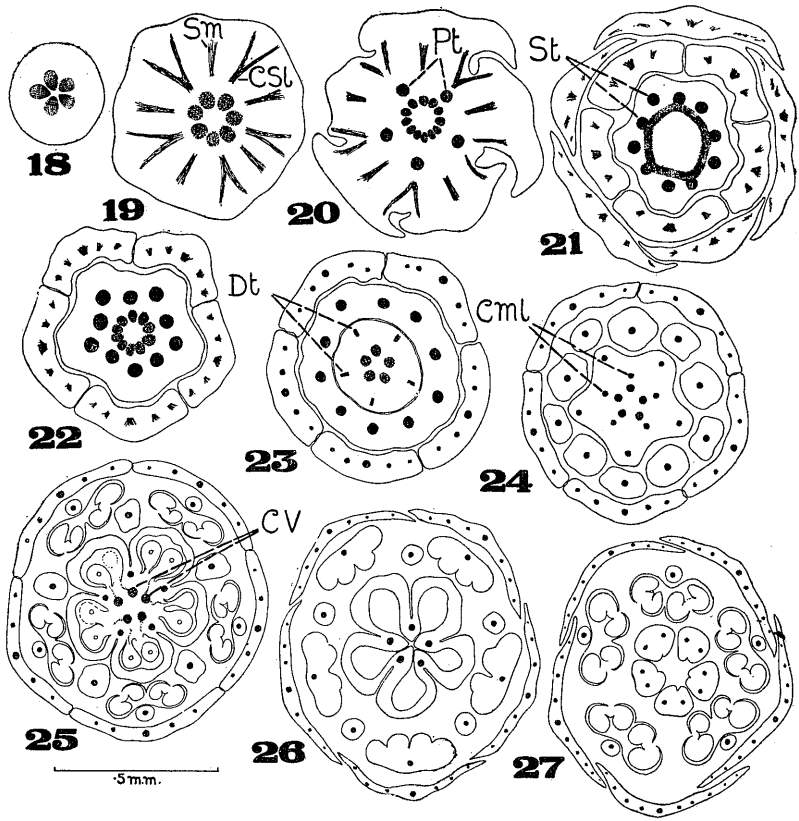
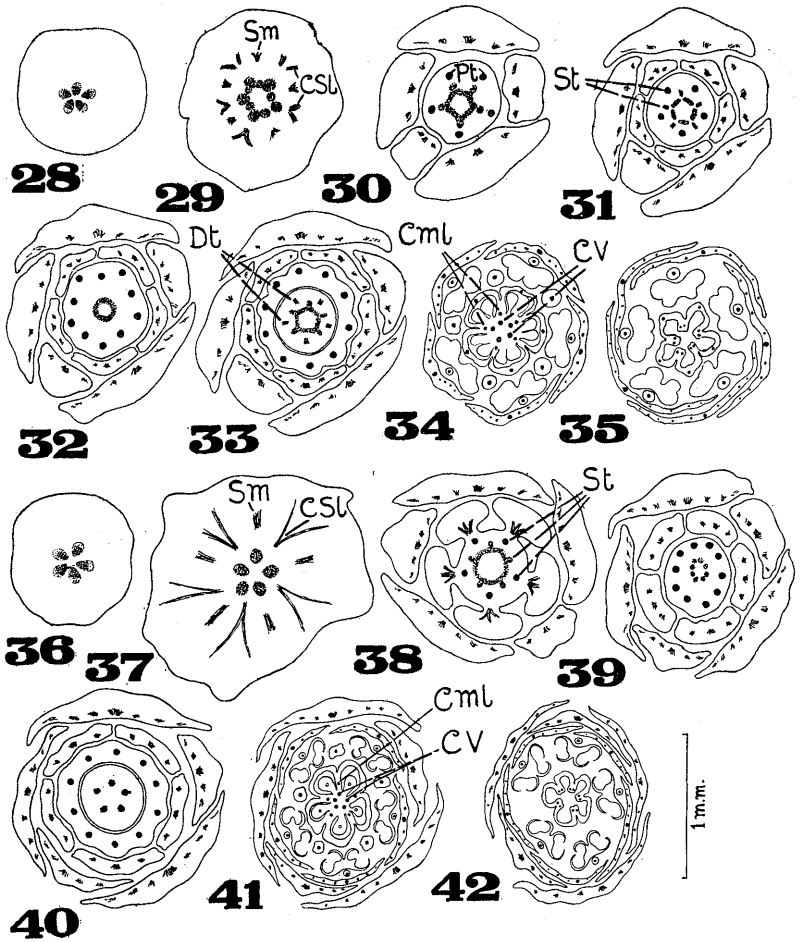


Figs, 1-17: 1-7. *Averrhoa bilimbi.* 8-17. *Averrhoa carambola.* 1-16. Transverse sections of flower buds showing the origin and distribution of traces to the different floral parts. 17. Longitudinal section of ovary showing the superposed arrangement of ovules. Sm. Sepal-medians; CSl. Common sepal laterals; Pt. Petal traces; St. Staminal traces; Dt. Dorsal carpellary traces; Cml. Common median laterals; CV. Common ventrals.



Figs. 18-27. *Biophytum intermedium.* Transverse sections of flower showing the origin and distribution of traces to the different floral parts.

1, 8, 18, 28, 36, 43). The stele expands in the thalamus and forms a closed ring of vascular tissue. The sepal medians and the common sepal laterals arise in two closely alternating whorls (Figs. 2, 9, 19, 29, 37). In *Sarcotheca subtriplinervis* they arise at the same level (Fig. 44). The common sepal laterals divide radially demarcating the laterals of adjacent sepals (Figs. 2, 9, 20, 29, 37, 44). At a higher level the petal traces arise independently from the main stele (Figs. 3, 10, 20, 30, 45). The traces for the antipetalous whorl of stamens are demarcated earlier than those of the antisepalous whorl (Figs. 4, 11, 21, 22, 31, 38, 46). Thus, the androecium in these species is obdiplostemonous. In *Averrhoa carambola* the staminodes repre senting the antipetalous stamens retain their vascular supply (Fig. 14). Above the



Figs. 28-42: 28-33. *Oxalis corymbosa*. 34, 35. *Oxalis latifolia*. 36-40. *Oxalis pubescens*. 41, 42. *Oxalis pescaprae*. Transverse sections of flower buds showing the origin and distribution of traces to the different floral parts.

level of origin of staminal traces five dorsal carpellary traces arise along the petal radii (Figs. 5, 12, 33, 48). In *Oxalis pescaprae* and *O. pubescens* they are completely suppressed (Figs. 39-42). In *Biophytum intermedium*, though the dorsal carpellary traces are demarcated, they fade out at the level where the bases of the loculi appear (Figs. 23-25). In the rest of the species they extend into the styles and terminate below the stigmas (Figs. 7, 16). The stele after the demarcation of

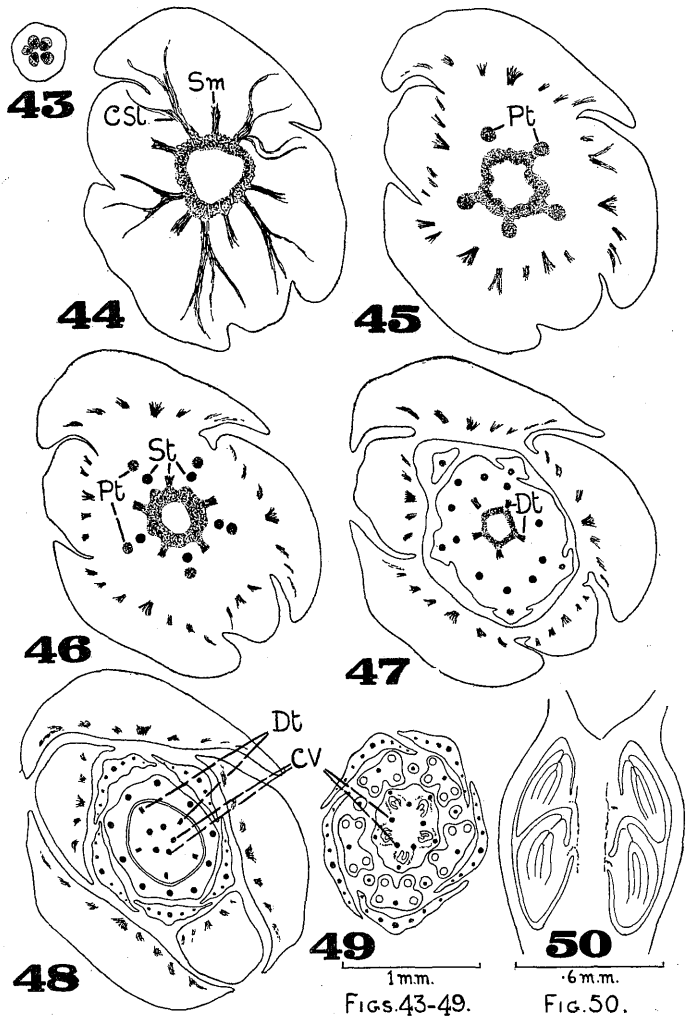
the dorsal carpellary traces organises into five bundles; these in *Averrhoa bilimbi* and *Sarcotheca subtriplinervis* function as the common ventral bundles (Figs. 6, 48, 49). In *Averrhoa carambola*, *Biophytum intermedium*, *Oxalis corymbosa* and *O. latifolia* they divide tangentially demarcating the common median lateral bundles and the common ventral bundles to the outside and inside respectively (Figs. 13, 14, 24, 25, 34). In *Oxalis pescaprae* and *O. pubescens* the main stele after the organisation of the staminal supply forms five bundles. They divide tangentially, and give rise to the common median lateral bundles to the outside and the common ventral bundles to the inside (Fig. 41). The common ventral bundles are completely utilized in the ovular supply, except in *Averrhoa bilimbi* and *Sarcotheca subtriplinervis* where they not only supply the ovules but also give rise to branches which enter the ovary wall (Figs. 6, 49). Towards the top of the ovary they divide radially demarcating the ventral bundles of the adjacent carpels, and they traverse the styles (Fig. 7). In *Averrhoa carambola* the ovary wall is vascularized by the branches arising from the common median lateral bundles (Fig. 14). In *Biophytum intermedium* and *Oxalis* species no wall supply is organised (Figs. 25, 26, 34, 35, 41, 42). The common median lateral bundles undergo radial splitting towards the top of the ovary, and the bundles thus formed extend into the styles (Figs. 15, 16, 27, 35, 42).

Discussion. A study of the floral anatomy of Oxalidaceae reveals certain points of similarity to the Geraniaceae and Linaceae.

The sepals in all the species included in the present study are three-traced and show quincuncial aestivation. The laterals of adjacent sepals arise conjointly. A tendency towards gamosepaly is noticed in *Oxalis* species and *Sarcotheca subtriplinervis*.

The free petals are single-traced and show contorted aestivation. However, imbricate aestivation in some flowers of *Averrhoa bilimbi* and quincuncial aestivation in *A. carambola* has also been observed.

The androecium is monadelphous and the stamens are single-traced. Early demarcation of the traces for the antipetalous stamens makes the androecium obdiplostemonous. Loss of fertility of the antipetalous stamens is noticed in *Averrhoa carambola*. But their vascular supply has not suffered reduction. A parallel situation is seen in the androecium of Meliaceae (Narayana, 1958) and Linaceae (Narayana, 1964; Narayana and Rao, 1966). In genera like *Aglaia* (Narayana, 1958) and *Ochthocosmus* (Narayana and Rao, 1966) the antipetalous stamens as well



Figs. 43-50. *Sarcotheca subtriplinervis*. Transverse sections of flower showing the origin and distribution of traces to the different floral parts.

as their vascular supply have suffered complete reduction. Duplication of the antipetalous whorl of stamens, reported in *Monsonia* and *Sarcocaulon* (Saunders, 1937) belonging to the Geraniaceae and *Ixonanthes icosandra* (Narayana and Rao, 1966) belonging to the Linaceae, occurs in *Hypseocharis* (Saunders, 1937).

The carpels are three-traced in *Averrhoa bilimbi* and *Sarcotheca subtriplinervis*, and five-traced in the rest of the species investigated. A tendency for the suppression of the dorsal carpellary traces is noticed in the family. In *Biophytum intermedium* though they are demarcated they fade away at about the level where the bases of of the loculi appear, while in *Oxalis pescaprae* and *O. pubescens* they are completely suppressed. Judging from the position of the common ventral bundles, the placentation may be described as anatomically parietal (Puri, 1952).

The systematic position of the genus *Sarcotheca* is controversial. It was placed under the Oxalidaceae by Hallier (1921) and Engler & Prantl (1931). Bentham & Hooker (1862-1893) included it under the Linaceae. Hutchinson (1959) placed it in the separate family, Lepidobotryaceae, along with two other genera *Lepidobotrys* and *Dapania*.

Sarcotheca comes near to the Linaceae in certain characters of floral anatomy. As in the Linaceae the number of ovules is two per locule. In the Linaceae the ovules are juxtaposed, and a placental obturator was reported in all the investigated taxa of the family (Narayana, 1964; Rao and Narayana, 1965; Narayana and Rao, 1966). *Sarcotheca* is also akin to the Oxalidaceae in the superposed condition of the ovules and the absence of an obturator. Thus, the present study justifies the position of *Sarcotheca* in the Oxalidaceae rather than in the Linaceae. According to Heimsch (1942) also *Sarcotheca* deserves a place in the Oxalidaceae. He observed "It may be mentioned that on the basis of wood structure the genus *Sarcotheca* justifiably is placed in the Oxalidaceae by Hallier than in the Linaceae". Thus, the findings from the present study as well as those from wood anatomy justify the position of *Sarcotheca* in the Oxalidaceae.

Summary

The floral anatomy of eight species distributed in four genera of the Oxalidaceae was investigated.

1) The sepals are three-traced and show quincuncial aestivation. The laterals of adjacent sepals arise conjointly. 2) The contorted petals are single-traced. Imbricate aestivation in *Averrhoa bilimbi* and quincuncial aestivation in *A. carambola* are also observed. 3) The obdiplostemonous androecium is monadelphous. In *Averrhoa carambola* the antipetalous stamens are reduced to staminodes which retain their vascular supply. 4) The carpels are three-traced in *Averrhoa bilimbi* and *Sarcotheca substriplinervis* and five-traced in the rest. The placentation

is anatomically parietal. 5) *Sarcotheca* is best placed in the Oxalidaceae.

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カタバミ科植物4属 8種の花部解剖の結果を報告する。1) がく片は5点性状配列で3葉跡を有する。隣接するがく片の側葉跡は合同して出る。2) 花弁は片巻き（回旋状）で1葉跡を有する。然しかわらがさね状（覆瓦状）の配列を *Averrhoa bilimbi* で，5点性配列でを *A. carambola* で観察した。3) 雄ずいは逆二重輪で単体である。*Averrhoa carambola* の花弁に対生する雄ずいは仮雄ずいに変化しているが，維管束はある。4) 心皮は *Averrhoa bilimbi* と *Sarcotheca subtriplinervis* では3葉跡を有するが，他の6種では5葉跡を有する。胎座は解剖学的には側膜胎座である。5) *Sarcotheca* 属はアマ科や Lepidobotryaceae に入れられたりもするが，やはりカタバミ科に入れるべきものである。